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Revision Basic

ADVANCED TECHNOLOGY DEVELOPMENT CENTER (ATDC)

RISK MANAGEMENT PLAN

Advanced Technology Development Center

May 11, 2001

SPACEPORT ENGINEERING AND TECHNOLOGY DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center

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RISK MANAGEMENT PLAN

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FOREWORD

This document is the Risk Management Plan for the Advanced Technology Development Center (ATDC). The project organization, roles, and responsibilities are contained in the ATDC Project Plan and it is understood that project management is risk management in the broadest sense. The risk management process described in this plan is designed to ensure that the early identification of risk occurs so favorable mitigation plans can be developed and implemented before the identified risks become problems that could negatively impact the project.

Although tailored and optimized for application to the ATDC Project, the ATDC risk management process is not unique. The effectiveness of the ATDC Risk Management Plan depends on the foresight to choose and use the correct tools in the process. As such, the NASA Continuous Risk Management (CRM) approach will be used. Also, the ATDC Project Team offers proven ability to manage project risk through both past performance and its current experience managing development projects.

Risk management activities associated with the development and execution of projects and programs are an integral part of the fabric of the project management process, not an add-on activity. While there is no special set of methods, tools, or communication mechanisms that will work for every project, the ATDC team has a core set of skills in facilities and equipment development, design, and risk mitigation. It is recognized that risk management processes, tools, and associated Safety and Mission Assurance (S&MA) engineering analyses (e.g., hazard analyses, failure modes and effects analyses, fault tree analyses), if not properly considered and applied, could result in significant program/project safety and reliability implications.

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ABBREVIATIONS AND ACRONYMS

ATDC	Advanced Technology Development Center
COTS	commercial off-the-shelf
CRM	Continuous Risk Management
DoD	Department of Defense
FTA	Fault Tree Analysis
HA	Hazard Analysis
KSC	John F. Kennedy Space Center
LO_2	liquid oxygen
MORT	Management Oversight and Risk Tree
NASA	National Aeronautics and Space Administration
OSHA	Occupational Safety and Health Administration
PRA	Probabalistic Risk Assessment
RIS	Risk Information Sheet
SAA	System Assurance Analysis
SAR	Safety Analysis Report
SEI	Software Engineering Institute
SE&T	Spaceport Engineering and Technology
SFA	Spaceport Florida Authority
S&MA	Safety and Mission Assurance
TBQ	Taxonomy-Based Questionnaire

1. INTRODUCTION

1.1 Purpose

Risk is the measure of the probability and severity of adverse effects or it is the possibility of suffering loss. However defined, risk has two basic elements: probability and consequence. Risk identification is the process of transforming uncertainties, concerns, or issues about a project into distinct risks that can be described, documented, and measured. Mitigation planning is the tool for selecting alternatives to reduce risk. The methodology to continually track progress, especially in areas where identified risk mitigation strategy is present, is essential for effective risk management. This allows for timely execution of mitigation plans and making adjustments as milestones are achieved and before identified risks become problems. The intent of the ATDC Risk Management Plan is to provide a disciplined and documented approach to risk management throughout the project life cycle and to support management decisionmaking in regard to risk assessments, taking into account cost, schedule, performance, and safety concerns. This whole process of risk identification, classification, analysis, mitigation or other disposition, tracking, controlling, communicating, and documentation in NASA is Continuous Risk Management.

1.2 Risk Management Responsibilities

The ATDC Project Manager is ultimately responsible for managing risk for the project. However, the entire Project Team will support the Project Manager throughout the risk management process to ensure all risks are identified, analyzed, mitigated, and tracked. No single team member will be responsible for ensuring overall risk management is performed other than the Project Manager. The ATDC individual responsible for official documentation of risks is the lead Safety and Mission Assurance Engineer. The risk management process will be integral in agendas, scheduling, cost estimating, and overall project management activities.

1.3 Risk Management Tools

Just like there is no special set of methods, tools, or communication mechanisms that will work for every project, there is not a special set of risk management tools that must be used for all projects. However, the NASA Continuous Risk Management process or approach is somewhat standard and widely used now throughout NASA and will assist in the identification of tools that can be used to mitigate risk. In addition, NASA senior management has placed emphasis on safety, risk management, and associated Safety and Mission Assurance (S&MA) engineering analyses such as fault trees, hazard analyses, failure modes and effects analyses, and probabalistic risk assessments. These tools, if not properly considered and applied, could result in either unnecessary costs or significant safety and reliability implications. As a general rule, the level of S&MA analyses performed is dependent upon the criticality, the energies involved, and the total program/project expectation and cost. Figure 1 shows some of the methods and tools that can be used during the various phases of risk management.

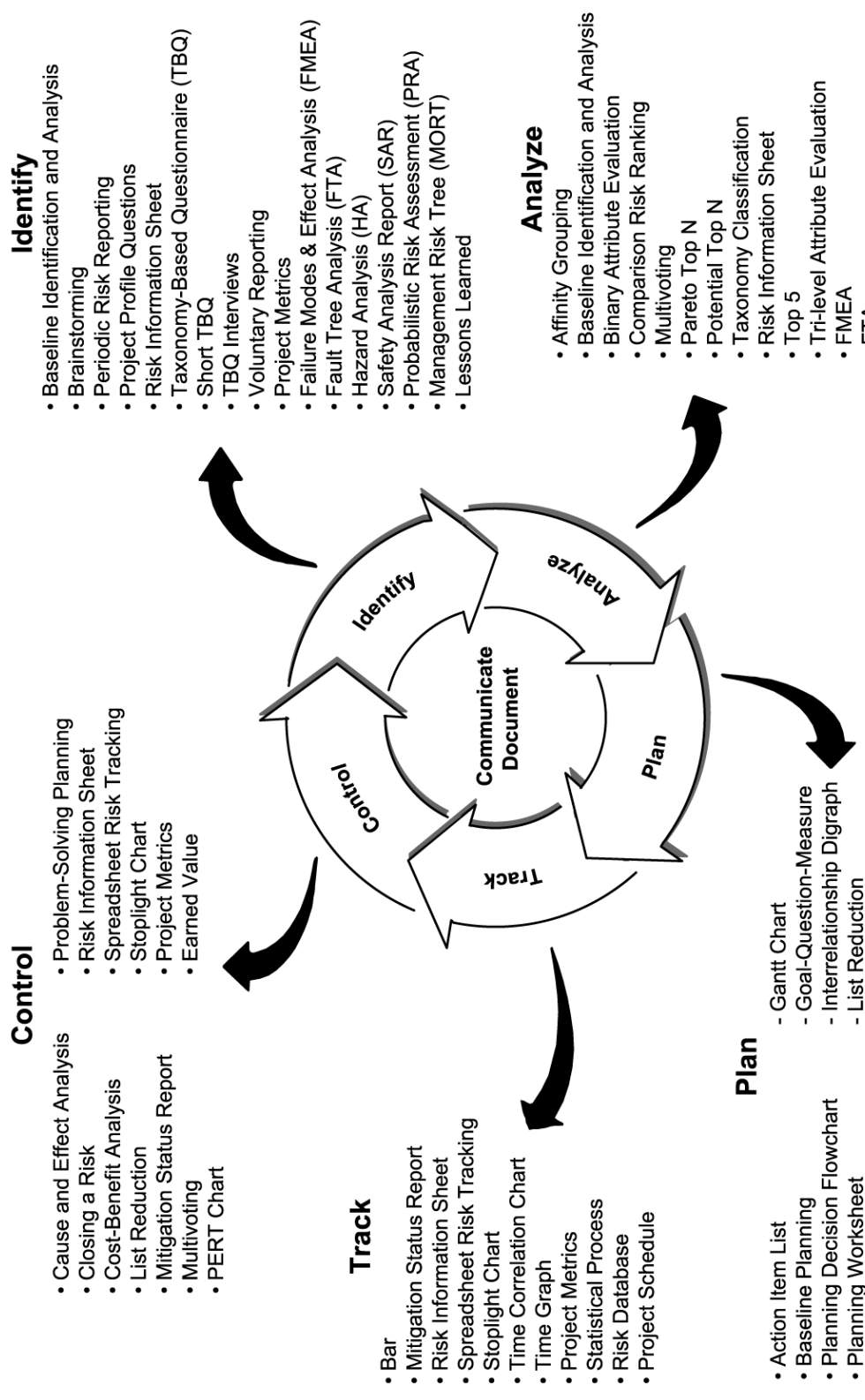

Figure 1. Risk Management Methods and Tools

2. RISK MANAGEMENT APPROACH

ATDC is a high visibility, unique project with multiple interfaces and a high demand for project success. Using the basic Risk Information Sheets and determining the status and acting upon them at every major milestone (or more frequently if deemed necessary by the Project Manager), ATDC risk management will identify, analyze, plan, track, control, communicate, and document risks. In ATDC, risk management is inherent in and provides an enabling tool for excellent project management.

2.1 Risk Management Success Criteria

ATDC risk management will be considered a success if the following conditions or their intent is met:

a. Formal and informal communication among the State of Florida Spaceport Florida Authority (SFA), the Air Force, and NASA John F. Kennedy Space Center is established to allow for open identification and successful resolution of concerns and issues. Problems arising from miscommunication or lack of communication will be the negative measure for this criterion.

b. An agreed-upon site plan prior to starting detailed design of the facility, an agreed-upon explosive site plan prior to starting construction, and an agreed-upon and approved explosive site plan prior to starting operations. Having zero site plan issues that must be "parked" in order to maintain schedule will be a measure of success.

c. An agreed-upon and signed-off set of detailed drawings, specifications, and supporting analyses, including the Facility Risk Indicator and System Assurance Analyses (SAA) at the 100% level by the scheduled milestone for each of these products. The construction contractor who has the ability to produce shop drawings with minimal clarification will be a measure of success. Having the Facility Risk Indicator documented prior to starting detailed design will be a measure of success. Having a list of design for safety guidelines and these items incorporated into each design will be a measure of success. Having the associated system SAA’s performed during and influencing the design phase and having them completed prior to operational use of the systems will be a measure of success for each phase.

d. All necessary permitting acquired by the scheduled milestones. The ability to start construction and use the facility in accordance with the schedule will be a measure of success.

e. Starting and completing the construction phase per schedule with no Occupational Safety and Health Administration (OSHA) reportable accidents. Having no

OSHA violations and having no OSHA reportable accidents will be a measure of success.

f. Being able to effectively perform Shuttle liquid oxygen (LO_2) pump testing, which is the first operational use of the ATDC, without impact caused by the ATDC development effort. The ability to start LO_2 pump testing in accordance with the schedule and the ability to complete LO_2 pump testing to the satisfaction of the Shuttle customer without impact caused by the ATDC development effort will be a measure of success.

g. Being able to obtain future business for the ATDC without impact caused by the ATDC development effort. Having a full "manifest" of paying customers will be a measure of success. Having favorable customer survey results will be a measure of success.

2.2 ATDC Risk Drivers and Strategy

Based on the risk drivers, the relative priorities of cost, schedule, and performance (including safety) control, and their perceived margins will be balanced. ATDC risk strategy focuses on the achievement of highest priority objectives with proper balance of the lower priority objectives. An adverse risk position for ATDC has the balance point too far on the user technical performance side (expectations too high), thus resulting in potential budget and schedule overruns. Similarly, having the balance point too far on the cost or schedule side would result in an unacceptable facility from a performance and usage standpoint. The ATDC strategy in this area is project phasing whereby capability is built incrementally, and there is opportunity to refresh existing capability as well as to initiate new capability depending upon available time and money. During the initial phases of ATDC, cost and schedule will be key drivers and, as ATDC grows, performance will be the key driver. Future expansion is integral to ATDC and allows some reduction in near-term performance while maintaining control of project resources and schedule.

The major risk drivers for ATDC are cost and ability to coordinate all the requirements to meet anticipated customer expectations. The initial cost estimates used in ATDC formulation are far below the current cost projections. Budget input refinements will be made and the ATDC "portfolio" must be expanded to acquire additional funding and fund sources. In order to conduct the ATDC development, partnerships must be developed between NASA and SFA, and between NASA and the Air Force; however, there is a high degree of partnering potential among other NASA, Government, and industry entities in an effort to build a world-class, modern, highly usable and expandable launch environment in situ technology development center. Excellent integration and coordination among all partners will be required to meet all the partner’s expectations as well as their basic requirements.

2.3 Risk Identification

Early identification and disclosure of risk and the development of mitigation plans are essential to an effective risk management process. Statements of risk will be captured first. In the ATDC Project, risks will be identified by:

a. Individual uncertainties - any team member can describe a risk he/she sees as negatively influencing the project.

b. Group uncertainties - risks can be identified in team meetings and milestone review.

c. Brainstorming - team members may meet specifically to list concerns and issues.

For ATDC, the 3-day NASA Continuous Risk Management Class was attended and an initial risk list was generated during the class workshop. Follow-on risk management workshops continued this initial effort and the ATDC project meeting schedule will reflect risk management workshops occurring on a monthly basis.

Specifically for ATDC, any team member can email a draft risk statement to the Project Manager to be discussed at the next weekly status meeting, at the next monthly risk management workshop, or at a specially called meeting. As a team, it will be decided whether or not the identified item is a risk that should be entered into the risk database, developed further, and tracked. Any team member can verbalize a potential risk at any ATDC meeting and decide if it should be proposed to the Project Manager for further action by the team. There are other tools that can be used to identify risks such as checklists, taxonomy-based questionnaires, metrics review, etc., and ATDC members may use these techniques in any of the above methods of risk identification.

2.3.1 Risk Information Sheet (RIS)

When the discovery of a specific risk occurs and it is being tracked, the risk information is entered into the ATDC risk management database by the individual responsible for official documentation of risks, the lead S&MA engineer. Risk Radar, an MS Access application created by Integrated Computer Engineering, Inc. under Federal Systems Integration and Management Center contract GSOOT98AJD0047, is the risk management database software that will be used for ATDC. Upon entering risk information, Risk Radar will create the RIS that will be used for risk discussions and the monthly risk management workshops. In the identification phase, the following is annotated on the RIS:

- Unique ID number
- Date risk is identified
- Risk Statement

- Origin - who or where the risk came from
- Risk Context - the what, when, where, how, and why

The risk context portion is required to provide enough background and additional information to ensure the original intent of the risk statement can be understood by others after time has passed. It captures information regarding circumstances, contributing factors, events, related issues, and interrelationships. A good context entry will allow a reader to have no doubt about what the source of risk is, its impact, who needs to help with mitigation and what he/she would do, and determine if the risk has gone away. An example of the typical RIS that ATDC will use can be found in figure 2.

2.4 Risk Analyzing and Classifying

After project risks are clearly identified and understood, the next step is to analyze and classify them. This aspect is relative and qualitative. It involves assigning each risk a value for probability, impact, timeframe, and rank. For ATDC, it is annotated as follows:

a. Probability - the possibility or likelihood of risk occurrence using percentages between 1 and 99%. Summary reporting will use five ranges, namely:

1 to 20% - Risk probability is very low (occurrence is improbable)
21 to 40% - Risk probability is low (unlikely to occur)
41 to 60% - Risk probability is moderate (occurrence is probable)
61 to 80% - Risk probability is high (likely to occur)
81 to 99% - Risk probability is very high (very likely to occur)

b. Impact - the consequence or severity of risk (loss or negative effect on the project) using an integer value between one and five where one is the lowest impact and five is the greatest impact as follows:

(1) Risk impact is very low - Negligible severity resulting in:

- No injury (possibly some aggravation)
- No system damage
- No political effect
- Minor budget deviation (<1%)
- Minor schedule delay (< 1 week)

Detailed Report: Risks by Rank **Advanced Technology Development Center (ATDC)** Report Dated May 08 2001

Risk ID 016 ***Complex 20 infrastructure may not support ATDC*** Ranked 1 out of 1 risks

Description: Complex 20 infrastructure (structure, water, electrical) may not support ATDC requirements; therefore, ATDC may have higher costs, schedule impacts, and expectations not fulfilled

Probability: 50 (%) **Exposure:** 2.50

Impact: 5 (1=low, 5=high) (Prob. x Imp.; .01 = very low, 4.95 = very high)

Impact Time Frame: Mar 27 2001 to: EOP **Days to Impact Time Frame:** 0

Impact Horizon: NEAR

Date Identified: Mar 13 2001 **Critical Path:** No

Responsible Person:

Program Area:

Affected Phase:

Risk Area:

Control:

Current Status: Mitigate

Contingency Plan

Move ATDC to a different area

Mitigation Plan

Reduce probability of unidentified weaknesses via walkdowns, PERs, studies, and real-time assessment

Step	Description	Person	Due Date	Done?
1	Walkdown facility to determine studies needed	Littlefield with J		Yes
2	Monitor Launch Mount PER	Burris	Jul 01 2001	No
3	Initiate Power Study with SGS	Clarke	Jul 01 2001	No
4	Assess Water line condition during Phase 1 (when uncovered and inspection can be performed	Littlefield	Jun 01 2001	No
5	Identify design and implementation options with roadway (fix potholes versus repaving)	Littlefield		No

Historical Events

Date	Person	Description
May 02 200	workshop	Reduce risk probability from 99% to 50% based on results of 45% PER for Launch Mount and learning that SFA is replacing the main water lines.

Version 2.02 for Access 2000 (January 2001) *1*

Figure 2. Example RIS Using Risk Radar

(2) Risk impact is low - Marginal severity resulting in:

- Minor personnel injury
- Minor system damage
- Customer replanning
- Budget deviation < 10% (but greater than 1%)
- Schedule slip < 3 months (but greater than 1 week)

(3) Risk impact is moderate - Moderate severity resulting in:

- Personnel injury
- Some system damage
- Adverse publicity
- Budget deviation around 10%
- Schedule slip around 3 months

(4) Risk impact is high - Critical severity resulting in:

- Severe personnel injury
- Major system damage
- Losing a customer or partner
- Budget deviation between 10 and 20%
- Schedule slip between 3 to 6 months

(5) Risk impact is very high - Catastrophic severity resulting in:

- Loss of life
- Loss of ATDC operational capability
- Project cancellation
- Budget overrun or underrun > 20%
- Schedule slip > 6 months

c. Timeframe - time when risk mitigation needs to occur using estimated dates and criteria. Summary reporting will use three ranges, namely:

(1) Near - Mitigation needs to occur within 2 months

(2) Mid - Mitigation needs to occur between 2 and 6 months

(3) Far - Mitigation needs to occur beyond 6 months

d. Rank - relative number used to rank risk importance so resources are placed on the most important "vital few" risks first. A ranking of 1 is the most important risk to work.

When risk impact is graphed against risk probability, a risk exposure "cube" can be generated. See figure 3. These graphical representations can be used singularly or combined so that level of exposure is clearly depicted. ATDC will use the 5-level classifications based upon the probability and impact ranges defined above until such a time a greater or lesser degree of classification is needed for risk sorting and ranking purposes. The proposed method for accomplishing ATDC risk prioritization is multivoting by the ATDC team on probability, impact, and timeframe. Representatives will review all the risks at risk workshops and various milestones and vote on their ranking of importance. The risk database software calculates an "exposure" (achieved by multiplying probability and impact) and this exposure number is used to create the initial ranking list. Where ties exist, the timeframe or multivoting is used to adjust the ranking. Adjustments to the RIS can be made anytime and they should be considered living, working documents. Communication is essential during and immediately following this effort with the whole team. Developing and maintaining the risk database is not the value of the risk mitigation process. Rather, the value lies in identifying risks proactively, taking appropriate actions against those risks, and coordinating/communicating those actions among ATDC Project Team members for the most effective and efficient use of time and other resources.

2.5 Risk Mitigation Planning

Risk exists everywhere in everything we do. ATDC will conscientiously deal with all risks identified; however, resources will not be allocated equally to all of them. Resources for risk management will be applied based on risk ranking and priority. Prior to involving the whole ATDC team in mitigation strategy, the following decision flowchart, figure 4, will be used by the person assigned to the particular RIS action. The Project Manager will name these actionees. If necessary, risk mitigation plans will link to resource plans and schedules whereby budget allocations and/or schedule allocations may be inserted to cover risks.

A risk can be accepted, mitigated, or watched. If it is accepted, this decision is documented with firm acceptance rationale and nothing more is done. An accepted risk will be handled as a problem if it occurs. No further resources are expended managing an accepted risk with proper risk acceptance rationale. If one cannot or does not need to act upon the risk until more information is obtained or the timing is right, then ATDC will monitor the risk for early signs of critical change and place it in the "watch" category. A tracking system will be used and attention will refocus on a watched risk in the event of change in probability, impact, timeframe, or other thresholds established within the RIS. A watched risk may result in an accepted risk, a risk that requires further mitigation, or just updated and left as a watched risk. For a risk where mitigation is required (normally most of them), the mitigation strategy includes eliminating or reducing the risk by:

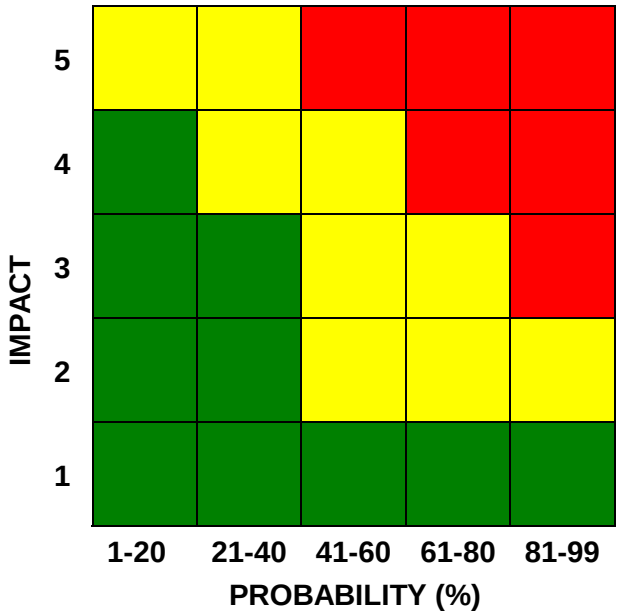

Figure 3. Risk Exposure Over Time

a. Reducing the impact

b. Reducing the probability

c. Shifting the timeframe

The order of precedence for risk reduction for ATDC will be similar to the safety hazard reduction and precedence sequence (eliminate, control, provide warning, accept). Realistic and measurable goals with success criteria are part of good mitigation planning. The ATDC Project Manager as well as the whole team must know when they have succeeded or failed to eliminate or mitigate a risk. Making this clear as part of the mitigation planning ensures:

a. Resources are not over committed

b. Conflicting mitigation plans are not implemented

c. Project objectives and constraints are not unintentionally violated

d. Major changes to scheduled milestones are avoided

e. Change requests unsupported by funding are eliminated

Not all mitigation plans can or should be carried out immediately and therefore contingency planning is identified on the RIS. These plans are held in reserve until specific conditions are

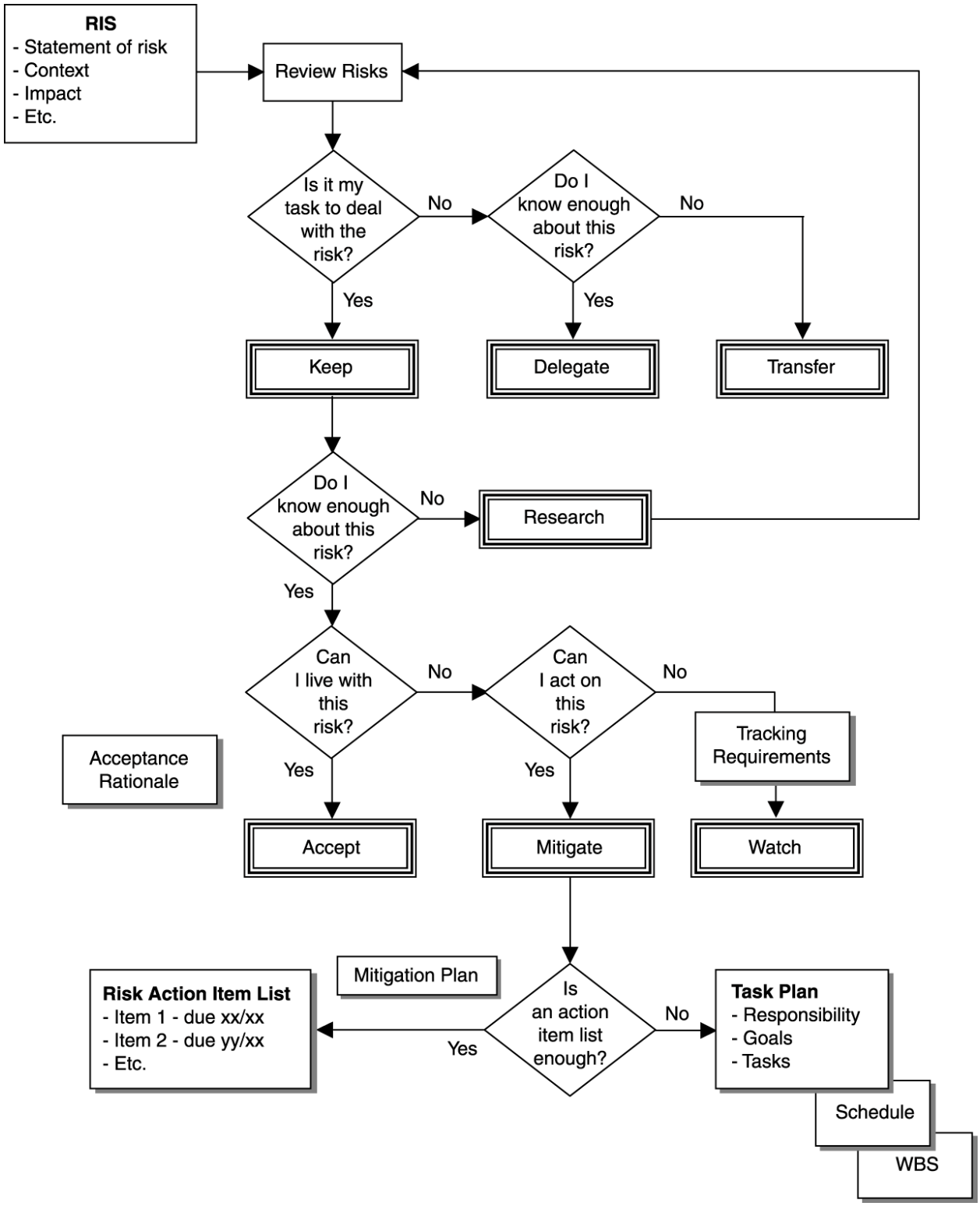

Figure 4. Planning Decision Flowchart

true or certain events occur. The whole team will watch for these conditions or events that would trigger the need to invoke contingency or mitigation planning actions. In ATDC, if mitigation planning results in recommendations that are extremely expensive given an extremely low probability, if there is insufficient time, or if they become totally impractical, then contingency planning recommendations will be invoked. A balanced approach in determining the appropriate level of risk mitigation is essential in developing effective risk management actions. Many times an action list is all that is necessary to ensure mitigation recommendations are acted upon. Sometimes, a separate task plan may be useful, especially if multiple risks dealing with complex recommendations can be resolved more easily. ATDC intends to use action lists until such time a task plan is recognized by the team as something more useful.

3. RISK MILESTONES

Major project milestones are important events within a project and normally the whole team is involved. At these milestones, project status is discussed, action items are reviewed, and approvals to move forward are given or denied. This is the most opportune time to build in risk milestones. The ATDC Project recognizes this and therefore all major milestone agendas will include risk management discussions. As a minimum, summary results of the risk tracking system will be provided and there will be an opportunity to discuss new or old risks. This process does not exclude risks from being discussed at any of the status or specially convened meetings.

3.1 Risk Tracking

Risk tracking is the process in which all risks data are acquired, compiled, analyzed, and reported. As previously mentioned, the risk tracking database called Risk Radar will be used for ATDC. It is an MS Access database that includes most of the RIS elements and standardized reports. These reports include:

a. Detailed reports, one risk per page, sorted by risk identification number or rank. These reports are the actual Risk Information Sheets.

b. Summary reports sorted by risk identification number, rank, or title. These reports are the actual risk lists.

c. Viewgraph reports for management briefings showing risks by rank or exposure cubes and descriptions.

d. Web reports in HTML format where a table of all risks is produced with the fields of title, impact, probability, description, contingency plan, and mitigation plan.

This database will be kept on a server and available for read access.

3.2 Risk Control

Risk control is the process in which decisions are made based on the data presented in the risk tracking reports. With the ATDC tracking database, risks can be controlled individually or in sets. Metrics, measures, and indicators chosen during mitigation planning will be tracked and used to provide meaningful information to enable more informed control decisions. On the RIS, indicators are documented in the "trigger" section. They can also be referred to as "thresholds." Triggers are the value of an indicator that specifies the level at which an action, such as implementing a contingency plan, may need to be taken. They are used to provide early warning of an impending critical event, to indicate the need to implement a contingency plan to preempt a problem, or to request immediate attention for a risk. Triggers are only effective if they do not trip unnecessarily and they are easy to calculate, track, and report. Control decisions are based on available information and experience and are required to respond to changing conditions in watched and mitigated risks. Some of the typical risk controls include:

- Performance/Technical Risk - additional system testing, designing in redundancy, building a full engineering model
- Cost Risk - using commercial off-the-shelf (COTS) hardware, providing sufficient funding during the early phases of the project's life-cycle, and management reserves
- Schedule Risk - "percentage complete" charts (however, insight may be too late in the process, increasing the probability of late deliveries and/or system capability impacts), sacrificing cost and/or performance goals
- Safety Risk (normally considered under technical/performance) - eliminate if possible, safety detection or protection systems, personnel warnings, procedural controls
- Political Risk - partnering and fostering communication

3.3 Risk Communicating

The ATDC team is empowered to share their issues and concerns with each other in an open manner. Open communication creates a better understanding of the status and progress of the ATDC Project because it brings forth perspectives of everyone on the project team. The ATDC Project Manager has created and will continue a culture that eliminates communications barriers and develops communications enablers. He will consider all documentation and communication as useful for the success of the project. All project team members can and should participate in defining and managing risks in their areas of expertise and responsibility. They must also communicate their risks, risk plans and actions, and risk mitigation progress. As previously stated risk communication will occur at milestones and is encouraged at all status and specially convened meetings. Also, the risk tracking database is available to the whole team.

4. RISK DOCUMENTATION

Documentation is a useful communications tool. Before and after ATDC successfully exists as a physical facility with systems that can carry out spaceport technology research and experiments, a tremendous amount of documentation will exist. Risk documentation will be among and integral to the total documentation effort. The primary risk documentation output is:

- This risk management plan
- Risk Radar reports
  - Risk Information Sheets
  - Risk lists by rank, risk identification number, or title
  - Risk exposure over time (impact versus probability cubes)
  - Summary viewgraphs
- Other documentation as needed such as separate risk task plans, integrated risk implementation plans, risk analysis reports, risk mitigation status reports, and risk test reports

Documentation that will be used to assist the overall risk management effort in ATDC (input) includes:

- NASA Continuous Risk Management Course book (see http://tkurtz.grc.nasa.gov/srqa/)
- Software Engineering Institute (SEI) Risk Management Guidebook (available in KSC library)
- 85K01002, ATDC Project Plan